BIO-TEK INSTRUMENTS INC.

M/N 250M

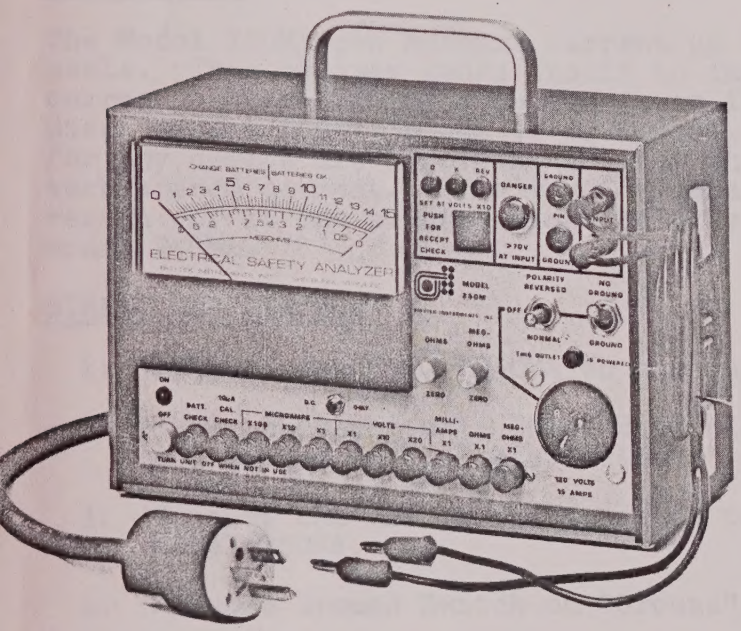
ELECTRICAL SAFETY ANALYZER

Burlington, VT

BIO-TEK INSTRUMENTS INC.

INSTRUCTION MANUAL

MODEL 250M ELECTRICAL SAFETY ANALYZER



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MODEL 250MA INSTRUCTIONS

INTRODUCTION

The Model 250MA is identical to the Model 250M and all the instructions in the 250M Manual apply to the Model 250MA. Instructions for measuring the current consumed by any device are discussed on this sheet.

APPLICATION

The Model 250MA can measure current up to 15 amperes ±2% of full scale. This ability lends itself to important measurements. The current consumption of a device is an important fact to know when diagnosing a faulty piece of equipment. The actual current needs for any device are important to know when distributing loads to each branch circuit. If circuit breakers blow frequently, the reason for it can be determined quickly and easily using the Model 250MA.

DIRECTIONS FOR USE

1. Connect the Model 250MA to a receptacle.
2. Push the Receptacle Check Button and verify proper polarity and ground of the receptacle.
3. Connect the device to be tested to the receptacle on the Model 250MA.
4. Put the Ground Switch on "Ground".
5. Put the Polarity Switch on "Normal".
6. Push Microamperes X1 Function Switch.
7. Push the Receptacle Check Button.
8. Turn the device ON.
9. The meter reads 0 to 15 amperes.
10. Record this value on a tag and attach to the device for reference.
11. Upon completion of the test, turn the Model 250M OFF.

SPECIFICATIONS

Current Scale:	0-15 amperes
Accuracy:	±2% of full scale
Maximum Voltage Drop:	.03 volts A.C.
Fused:	15 amp, Type 3AB

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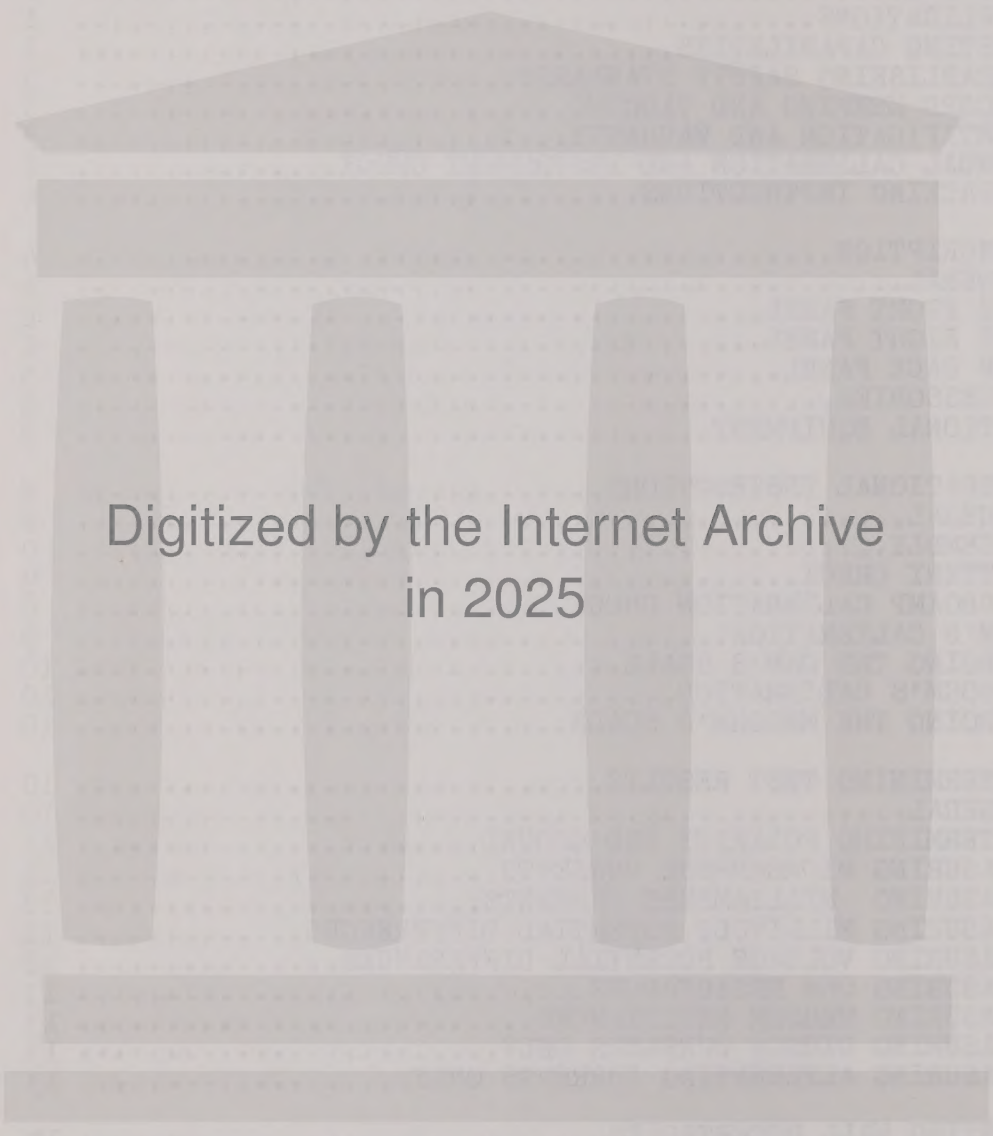
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1.0 INTRODUCTION.

1.1 GENERAL. The Model 250M Electrical Safety Analyzer is a portable, solid state instrument designed to perform all of the routine tests required for determining if electrically-operated devices, conductive surfaces and receptacles are electrically safe for use in accordance with nationally recognized safety standards.

The 250M has an internal resistance that duplicates the impedance the human body has to the flow of electrical current. By simulating the human body the 250M's test results indicate the actual current levels that would pass through the body if it were to offer a path for leakage currents.

The 250M is completely portable and provides accurate results quickly. This is accomplished by combining large, well defined meter scales with push button controls. This is the only instrument available capable of providing microampere, milliampere, millivolt, volt, ohm and megohm test results while simulating worst case conditions. As an added benefit the 250M can measure the voltage available at a receptacle while testing the ground and polarity of the receptacle.

1.2 APPLICATIONS. The 250M provides exact, detailed data on the various electrical characteristics that will determine if a device is electrically safe for use.

As a quality assurance test instrument it provides the means to test devices before they are placed into service. The 250M's wide range of testing capabilities will not only indicate if the device is safe during normal operating conditions, but will also show if the device becomes an electrical hazard under worst case conditions.

Incorporated into a routine safety program, the 250M provides long term as well as immediate benefits. By maintaining accurate records of the test results obtained during each electrical safety survey, electrical degradation of a device will be readily evident so that it can be removed from service before it becomes an electrical hazard.

In addition, this data will be useful whenever additional purchases of a device are being considered. By reviewing the amount of repair time required for a given instrument, along with its safety record, it can be decided if repurchasing is a practical idea.

1.3 TESTING CAPABILITIES. Model 250M is designed to perform tests recommended by the majority of nationally recognized agencies that issue safety standards. In conjunction with optional accessories, the 250M provides the means to perform the tests and measurements outlined in the following sections. Those tests and measurements with an asterisk (*) before them indicate a need for optional instrumentation.

RECEPTACLES.

.Determine the polarity of each receptacle;
.Determine if each receptacle is grounded;
.Measure the available voltage of each receptacle;
.Determine if the metal face plate of the outlet is grounded;
.Measure the potential differences and resistances between the grounding pole of one receptacle and the grounding pole of each of the other receptacles;
.Measure the potential differences and resistances between the grounding pole of a receptacle on one branch circuit and the grounding poles of receptacles on a different branch circuit fed by the same distribution panel;
.Measure the potential differences and resistances between the grounding pole of each receptacle and the grounding point that services them.

APPLIANCES.

.Measure the potential differences between the appliance's exposed conductive surfaces and the grounding point that services it;
.Measure the resistances between the appliance's exposed conductive surfaces and chassis, and the grounding pin of the plug;
.Measure leakage currents from appliances not likely to contact electrically sensitive individuals;
.Measure leakage currents from appliances likely to contact electrically sensitive individuals;
.Measure leakage currents from an appliance when it is:

grounded with normal polarity,
grounded with reversed polarity,
ungrounded with normal polarity,
ungrounded with reversed polarity;

.Measure resistances between each current carrying blade of the appliance's plug and its grounding pin.

APPLIANCES WITH LEADS.

.Measure leakage currents from isolated patient leads;
.Measure the leakage currents from non-isolated patient leads;
.Measure the leakage currents between leads;
.Measure potential differences between leads;
.Measure resistances between leads and exposed conductive surfaces.

ISOLATED POWER SYSTEMS.

*Measure the current necessary to trip the line isolation monitor;
*Measure the impedance to ground of each energized conductor;
*Measure the potential differences between is grounding point and other grounding points;
*Measure the resistances between its grounding point and other grounding points;
*Measure the voltage drop of the branch circuit;
*Measure the potential differences between its grounding point and all appliances, fixed equipment and exposed surfaces serviced by i

FIXED EQUIPMENT.

.Measure the potential difference between exposed conductive surfaces of fixed equipment serviced by the same distribution panel;
.Measure the resistance between exposed conductive surfaces of fixed equipment and the grounding pole of a power receptacle serviced by the same distribution panel;
.Measure the potential differences between exposed conductive surfaces of fixed equipment serviced by different distribution panels;
.Measure the resistance between exposed conductive surfaces of fixed equipment serviced by different distribution panels;
.Test for continuity of ground between each grounding point and the exposed conductive surfaces of fixed equipment it services;
.Measure leakage currents from permanently wired, fixed equipment.

CONDUCTIVE SURFACES.

.Measure the potential difference between the grounding pole of one of the receptacles and each exposed conductive surface;
.Measure the resistance of the grounding cord servicing each exposed conductive surface;
.Measure the potential difference between each conductive surface located in a given area;
.Measure the resistance between each grounding point and the exposed conductive surfaces it services;
.Test for continuity of ground between a given grounding point and the exposed conductive surfaces it services;
.Measure the leakage currents from exposed conductive surfaces.

1.4 ESTABLISHING SAFETY STANDARDS. Due to the great variations in acceptable standards presently being suggested and enforced by the various agencies, organizations, and institutions, this manual does not include suggested acceptable levels for each test procedure.

Each test should be performed in accordance with the test procedures presented in this manual, but refer to your safety program's specifications to determine if the results obtained are acceptable, or if the item tested should be repaired or replaced.

If there is any doubt about the standards you should use, write to the appropriate agency. If you prefer, write to Bio-Tek Instruments for this information, specifying the application and area of concern. Bio-Tek Instruments has a manual on safety testing and standards available at a nominal cost.

1.5 RECORD KEEPING AND TAGGING. Bio-Tek Instruments has a complete record keeping and tagging system available that will fit into any program. Write or call the Sales Department, Bio-Tek Instruments, Inc., 5000 Shelburne Road, Shelburne, Vermont 05482 for information.

1.6 CERTIFICATION AND WARRANTY. Bio-Tek Instruments, Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory.

All Bio-Tek Instruments, Inc. products are warranted against defects in material and workmanship. This warranty applies for one year after delivery. This warranty excludes batteries and fuses. The warranty must be validated by completion and prompt return of the warranty card enclosed with the instrument at the time of shipment.

1.7 ANNUAL CALIBRATION AND INSTRUMENT CHECK. We recommend that each Model 250M be recalibrated annually. Calibration instructions are included in this manual in section 13.0. If the purchaser does not possess the necessary equipment for proper recalibration, return the Model 250M to the factory, prepaid with a purchase order for recalibration. Cost for this service including return shipping is $25.00. This excludes the cost of any parts.

For calibration, the meter should be shipped to:

Service Department
Bio-Tek Instruments, Inc.
5000 Shelburne Road
Shelburne, Vermont 05482

via Parcel Post or UPS and insured for $500.00.

1.8 UNPACKING INSTRUCTIONS.

1. Unpack the shipping carton;

2. Check contents of the shipping carton for the following:

   a) Model 250M Electrical Safety Analyzer
   b) Leads (one red and one black with banana plugs on each end)
   c) Long red probe
   d) Large clamp
   e) Ground adapter
   f) NEMA adapter
   g) Calibration sheet
   h) Warranty card
   i) Three mercury batteries

2.0 DESCRIPTION.

2.1 GENERAL. The 250M is packaged in a compact aluminum case that provides for ease in carrying while protecting the electronic circuitry from damage. The operational controls are all located on the front panel along with the various display systems for reading test results. The back panel contains the required accessories as well as a power cord for the front panel receptacle. Fuses are also located here and both the back and right side panel contain wraparounds for the power cord and leads.

2.2 THE FRONT PANEL. The meter face located in the top left of the panel has two scales. The black scale of 0 to 15 is for reading all of the microamps, millivolts, volts, milliamps and ohms results (reading from left to right). The lower red scale of 0 to infinity is for reading megohms only, and reads from right to left.

Below and to the left of the meter face is the function selector's ON-OFF light which indicates when the batteries are in use. To its right is a button that, when depressed during current or potential difference measurements, will display only the D.C. voltage or current.

Starting at the left bottom corner and stretching three-quarter's across the panel are the individual functional control buttons. The grey button is the ON-OFF button; the first black button checks the batteries while the second one is the 10 microamp calibration chec button.

The remaining black buttons from left to right are microamps X100, X10 and X1 (these are also used for millivolt testing). Next are the volts X1, X10 and X20. The remaining two black buttons are milliamps X1 and ohms X.1 respectively. The red button is for megohms X1. Each button is color-coded to the meter scale it is read on.

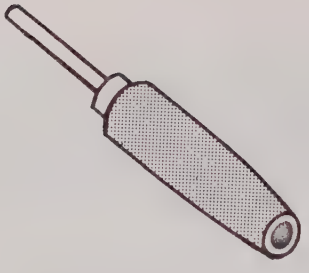
To the top right of the meter is the receptacle tester containing three neon lights and a push button. To its right is a "DANGER" lamp for inputs greater than 70 volts. Below the receptacle tester are the ohms and megohms zeroing knobs.

In the far right corner of the panel are two sets of color-coded jacks. The two at the edge of the panel are for signal and ground inputs whereas the other two are for internal testing. Below them are the two switches which control the power, polarity and ground of the receptacle in the right bottom corner. Between the switches and the receptacle is a light to indicate if the receptacle is powered.

2.3 THE RIGHT PANEL. A wrap-around for the red and black leads is located here.

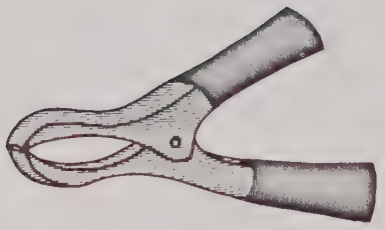
2.4 THE BACK PANEL. All of the accessories for normal operation of the 250M are located here (except for the red and black leads). In addition, the six foot power cord that operates the front panel's receptacle is located here. The two black wrap-around bars to the top of the panel are supplied for securing the power cord. Between them are the 12 and 1 amp fuse holders along with two spare fuses. The female receptacle to the right of the 1 amp fuse holder is for connecting the optional Model 10.

2.5 ACCESSORIES. The Electrical Safety Analyzer comes complete with the accessories necessary to test all normally wired electrical devices and wall receptacles.



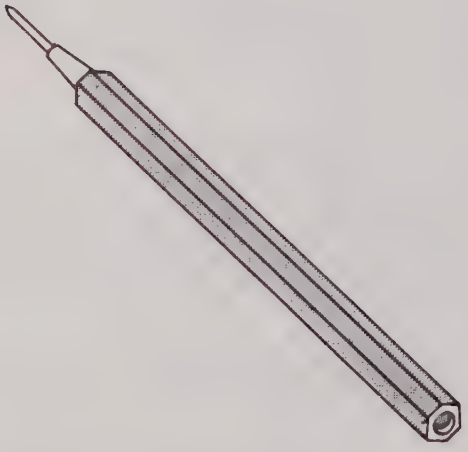
The Ground Adpater is a small metal and plastic adapter that has a male metal ground plug at one end with a female banana jack at the other.

It is used to adapt leads as a grounding plug for either a wall receptacle or similar device.



The Large Clamp consists of a large copper alligator clip with handles covered by plastic; one of the handles has a female banana jack at its end.

By inserting a lead into the clamp's banana jack the clamp can be used to obtain firmer electrical contacts for either better ground or test results.



The Probe is six and one-half inches long and covered with red plastic; one end has a sharp metal point while the other has a female banana jack.

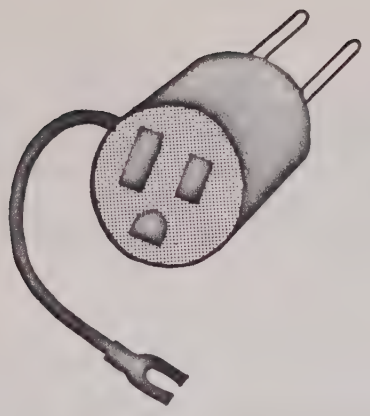
The probe fits onto the banana plug at the end of a lead and by using the sharp metal point on the metal parts of an electrical device, firm electrical contact can be made.

Devices that are painted can be tested by applying extra pressure on the probe's point so that the paint can be penetrated and the point placed in contact with metal.

Two Leads are supplied; they are five feet long and made of insulated wire. One lead is color-coded red and the other black.

Both leads have banana plugs at each end with contact holes located just before the plug end.

The red lead always goes into the 250M's red input jack and the black lead always goes into the black input jack.



The NEMA Adapter, or Cheater, has a three-prong receptacle at one end with two electrical blades at the other; in the middle is a grounding wire.

It may be used to convert two-blade wall receptacles into grounded, three-blade receptacles.

2.6 OPTIONAL EQUIPMENT. Certain special tests not routinely performed can be accomplished by using the 250M in conjunction with one of its optional accessories.

MODELS NF23-1 and NF23-2. These two accessories provide the means to test receptacles and equipment that are designed specifically for explosion proof environments. They are required for testing explosion proof receptacles and plugs.

MODEL 10. This unit provides the ability to quickly test leads for leakage current; it also provides isolation testing of leads using a 120 volt source with a suitable resistance to each lead. In addition the Model 10 is required for testing an Isolated Power Distribution System's trip alarm.

3.0 OPERATIONAL INSTRUCTIONS.

3.1 GENERAL. The 250M can be operated in two different modes, semi-automatic or manual. The difference between the two is that the semi-automatic mode requires the minimum amount of operator manipulation and provides test data quite rapidly. The manual procedures provide the operator use of the 250M whenever there isn't a power source available. Each procedure presented in this manual describes that which provides the fastest method for the specific task. To obtain techniques for different test methods write to Bio-Tek Instruments specifying the particular test method and purpose.

The 250M is completely independent of an external power source and utilizes two 9 volt batteries for obtaining test measurements. Whenever a button other than the grey "OFF" button is depressed the batteries are being utilized; therefore the "OFF" button should always be depressed when testing is completed. This can be verified by the light above the grey button which is lit when on and not lit in the "OFF" position.

The red and black leads must always be inserted in their corresponding color-coded "INPUT" jacks. When using the probe or clamp during testing, always make firm contact with metal to insure proper results.

The ohms circuit is protected by a one amp fuse. This fuse will blow whenever the leads are connected to 120 volts while the ohms X1 button is pushed.

The 250M provides the most accurate results when resting on a flat surface or when held upright. If any of the test results appear to be incorrect do not proceed with any further testing until corrective action has been taken and the 250M is operating properly.

Immediately discontinue testing if the "DANGER" light on the 250M lights during testing; being careful not to touch the device, remove its power cord from the receptacle.

3.2 ASSEMBLY.

1. Install the batteries in accordance with Section 12.2;
2. Take one end of the red lead and insert it into the 250M's red "INPUT" jack;
3. Take one end of the black lead and insert it into the black "INPUT" jack.

NOTE: To facilitate testing, it is recommended that the red and black leads always be left in their corresponding, color-coded "INPUT" jacks. When not in use they should be coiled around the right panel's wrap-around.

3.3 BATTERY CHECK. It is recommended that the battery check be performed prior to each test series whenever there is a time lag between testing.

1. Push the "BATT. CHECK" button;

ACTION: If the meter reads to the right of the black line located at the top of the meter ("BATTERY O.K.") then the batteries are good.

If the meter reads to the left of this black line (CHANGE BATTERIES) the batteries must be replaced; see Section 12.2.

3.4 MICROAMP CALIBRATION CHECK. It is recommended that the microamp calibration check be performed prior to each microamp test series whenever there is a time lag between testing.

1. Push the "CAL. CHECK" 10 microamp button.

ACTION: If the meter indicates between 9.7 and 10.3 microamps on the black scale, the 250M is functioning properly.

If the meter does not indicate between 9.7 and 10.3 microamps, then refer to Section 13 for calibration instructions.

3.5 OHM'S CALIBRATION. It is recommended that the ohm's calibration check be performed at least once a month.

1. Push the OHM X.1 button;
2. Hold the metal ends of the red and black jack firmly together;
3. Turn the "OHMS ZERO" knob and adjust the needle to read zero on the black scale;

4. Plug the leads into the red and black banana jack on the back panel labeled 1 ohm "RESISTANCE CAL. CHECK".

ACTION: If the meter indicates between 9.25 and 10.75 on the black scale, the ohm scale is calibrated. Proceed to the next step.

If the meter doesn't indicate 9.25 and 10.75 on the black scale, turn to Section 13 for ohm calibration.

3.6 ZEROING THE OHM'S SCALE. For accurate results, the ohms scale must be zeroed prior to each ohm's test series.

1. Push the black OHMS X.1 button;
2. Hold the metal ends of the red and black leads firmly together;
3. Using the "OHMS ZERO" knob, zero the needle on the black scale.

3.7 MEGOHM'S CALIBRATION. It is recommended that the megohm's calibration check be performed at least once a month.

1. Push the red MEGOHM X1 button;
2. Hold the metal ends of the red and black leads firmly together;
3. Using the "MEGOHM ZERO" knob, zero the needle on the red scale, (on the right).
4. Plug the leads into the red and black banana jack on the back panel labeled 1 megohm "RESISTANCE CAL. CHECK".

ACTION: If the meter does not indicate 1 megohm $\pm$10%, see Section 13.0 for calibration instructions.

3.8 ZEROING THE MEGOHM'S SCALE. For accurate results the megohm's scale must be zeroed prior to each megohm test series.

1. Push the red MEGOHM X1 button;
2. Hold the metal ends of the red and black leads firmly together;
3. Using the "MEGOHM ZERO" knob, zero the needle on the red scale (on the right).

4.0 DETERMINING TEST RESULTS.

4.1 GENERAL. Receptacle testing data is visibly presented using the three neon lights located above the "RECEPT. CHECK" button. All of the results obtained while a black button is depressed are read on the black meter scale and multiplied by the multiplier above the specific button; the red button's results are read on the red scale.

4.2 DETERMINING POLARITY AND GROUND. Model 250M determines the ground and polarity of a receptacle using the three neon lamps located above the "RECEPT. CHECK" button. By simply pushing the button and using the following chart it can be determined what the receptacle's ground and polarity are. (● = Lit O = Not Lit)

O	K	REV	Receptacle's Condition
●	●	O	Grounded with normal polarity;
●	O	●	Grounded with reversed polarity;
●	O	O	No ground with reversed polarity;
●	O	O	No ground with normal polarity;
O	●	O	Grounded; hot to hot, no neutral;
O	O	●	Grounded; hot to neutral, no neutral;
O	O	●	Grounded; reversed polarity and blown fuse;
O	O	O	Grounded; normal polarity and blown fuse;
O	O	O	No ground; reversed polarity and blown fuse;
O	O	O	No ground; hot to hot and no neutral;
O	O	O	No ground; hot to neutral and no neutral.

4.3 MEASURING MICROAMPERE CURRENTS. Model 250M measures microamps in three ranges using the 0-15 black meter scale to display the results. Current levels are measured by reading the meter and then multiplying the result by the multiplier printed above the button pushed.

Start the testing by pushing the MICROAMP X100 button. If the meter indicates below 1.5 push the X10 button. If still below 1.5 push the X1 button. The button pushed that has a meter reading between 1.5 and 15 is the proper range; record the results in accordance with the following examples:

EXAMPLE 1. If the MICROAMP X100 button is pushed and the meter indicates 9.5, then the current is 9.5 X100 = 950 microamps.

EXAMPLE 2. If the MICROAMP X10 button is pushed and the meter indicates 11.5, then the current is 11.5 X10 = 115 microamps.

EXAMPLE 3. If the MICROAMP X1 button is pushed and the meter indicates 5.25, then the current is 5.25 X1 = 5.25 microamps.

4.4 MEASURING MILLIAMPERE CURRENTS. Model 250M measures milliamps in one range using the 0-15 black meter scale to display the results. Current levels are measured by reading the results directly from the meter when the MILLIAMPS X1 button is pushed.

EXAMPLE: If the MILLIAMPS X1 button is pushed and the meter indicate 9.5, then the current is 9.5 X1 or 9.5 milliamps.

4.5 MEASURING MILLIVOLT POTENTIAL DIFFERENCES. Model 250M measures millivolts at the same time it measures microamperes (V= IR; where I = meter reading in microamps and R = 1,000 ohms). Follow the procedure in 4.3 and substitute millivolts for microamps.

4.6 MEASURING VOLTAGE POTENTIAL DIFFERENCES. Model 250M measures voltages in three ranges using the 0-15 black meter scale to display the results. Voltage levels are measured by reading the meter and then multiplying the result by the multiplier printed above the button pushed.

EXAMPLE 1. If the VOLTS X1 button is pushed and the meter indicates 9.5 then the voltage is 9.5 X1 or 9.5 volts.

EXAMPLE 2. If the VOLTS X10 button is pushed and the meter indicates 9.5, then the voltage is 9.5 X10 or 95 volts.

EXAMPLE 3. If the VOLTS X20 button is pushed and the meter indicates 9.5, then the voltage is 9.5 X20 or 190 volts.

4.7 MEASURING OHM RESISTANCES. Model 250M measures ohms in one range using the 0-15 black meter scale to display the results. Resistance levels are measured by reading the meter and then multiplying the result by the multiplier printed above the button pushed.

EXAMPLE: If the OHMS X.1 button is pushed and the meter indicates 9.5, then the resistance is 9.5 X.1 or .95 ohms.

4.8 MEASURING MEGOHM RESISTANCES. Model 250M measures megohms in one range using the 0 to infinity red meter scale to display the results. Resistance levels are measured by reading the results directly when the red MEGOHMS X1 button is pushed.

EXAMPLE: If the red MEGOHMS X1 button is pushed and the meter indicates .7, then the resistance is .7 X1 or .7 megohms.

4.9 MEASURING DIRECT CURRENTS ONLY. Model 250M measures currents and voltages by summing the D.C. and A.C. signals. By using the "D.C. ONLY" button it is possible to read the direct current separately. To read D.C. only, push the appropriate current or voltage button, observe the reading and then push the "D.C. ONLY" button; the result is the direct current.

EXAMPLE: If the MICROAMP X1 button is pushed and the meter indicates 9.5 then the total current is 9.5 microamps; if the "D.C. ONLY" button is pushed and the meter drops to 5.0 then the direct current is 5.0 microamps.

4.10 MEASURING ALTERNATING CURRENTS ONLY. Model 250M measures alternating currents only by summing the A.C. and D.C. then subtracting the D.C. as presented in 4.9. The remainder is the alternating current only.

EXAMPLE: Follow the steps in the example of Section 4.9; subtract the D.C. reading of 5.0 from the total of 9.5; the alternate current is 9.5 - 5 or 4.5 microamps.

5.0 TESTING WALL RECEPTACLES.

5.1 GENERAL. This section presents the various test that the 250M is capable of performing on polarized, 2 pole, 3-wire grounding type receptacles. To test ungrounded receptacles see Section 5.2 for pre-testing instructions; for explosion-proof receptacles see Section 10.

The procedures presented in this section are not meant to imply a safety testing program. See Sections 1.4 and 1.5 for recommended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp become lit there is greater than 70 volts across the leads; under certain conditions this can present a hazardous situation for the operator.

5.2 TYPES OF RECEPTACLES. This analyzer may be used for testing all common types of receptacles. For those receptacles of unusual configurations additional accessories are necessary to perform the electrical safety tests.

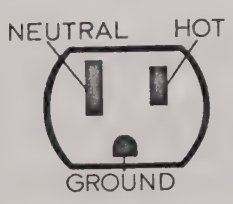
All two-blade receptacles that do not provide a position for grounding must be adapted with a NEMA Adapter.

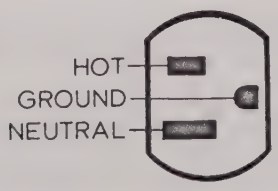
Receptacles used in explosive chemical or electrically sensitive areas usually are of the Twist Lock Type. To test this type receptacle a Bio-Tek Model No. 23-1 Adapter is necessary; see Section 10.

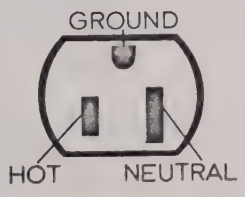
The standard grounded receptacle that can be used with three-prong plugs can be tested without any additional accessories.

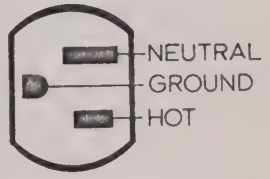
5.3 POSITIONS OF THE RECEPTACLE. All receptacles should always have a common electrical configuration.

Before performing the following tests carefully examine the receptacle to be tested and find its counterpart in the following illustrations.









PLEASE NOTE! ONE END OF THE BLACK LEAD IS ALWAYS CONNECTED TO THE BLACK "INPUT" JACK, AND ONE END OF THE RED LEAD IS ALWAYS CONNECTED TO THE RED "INPUT" JACK, FOR ALL TESTS PER INSTRUCTION IN SECTION 3.2.

By comparing the above illustrations with the receptacle to be tested, it can be determined which of the blade openings of the test receptacle should be "HOT" and "NEUTRAL".

5.4 TESTING FOR POLARITY AND GROUND.

1. Plug the 250M into the receptacle under test;
2. Push the green "RECEPT. CHECK" button;
3. See Section 4.2 for determining test results.

5.5 MEASURING AVAILABLE VOLTAGE.

1. Plug the 250M into the receptacle under test;
2. Depress the black "VOLTS X10" button;
3. Push the green "RECEPT. CHECK" button;
4. See Section 4.6 to determine results.

5.6 MEASURING POTENTIAL DIFFERENCES BETWEEN RECEPTACLES.

1. Insert the red lead's plug into the ground adapter;
2. Insert the black lead into the 250M's black jack labeled "GROUND";
3. Plug the 250M into a receptacle known to be grounded;
4. Insert the ground adapter into a second receptacle's ground;
5. Depress the black "MICROAMP X100" button;
6. See Section 4.5 to determine results.

5.7 MEASURING RESISTANCES BETWEEN RECEPTACLES.

1. Insert the red lead's plug into the ground adapter;
2. Insert the black lead into the 250M's black jack labeled "GROUND";
3. Depress the black "OHMS X.1" button;
4. While making firm contact between the ground adapter on the red lead and the 250M's ground pin (of the power cord's plug zero the ohm's scale in accordance with Section 3.6;
5. Plug the 250M into a receptacle known to be grounded;
6. Plug the red lead with ground adapter into the ground of another receptacle;

7. See Section 4.7 to determine results.

5.8 MEASURING RESISTANCES BETWEEN GROUNDING RECEPTACLES AND EXPOSED METAL SURFACES.

1. Insert the black lead into the 250M's black "GROUND" jack;
2. Insert the red lead into the probe;
3. Depress the black "OHMS X.1" button;
4. While making firm contact between the probe on the red lead and the 250M's ground pin, zero the ohm's scale in accordance with Section 3.6;
5. Plug the 250M into a previously tested, polarized 2 pole, 3-wire, grounded receptacle;
6. Make firm contact between the probe on the red lead and the exposed surface;
7. See Section 4.7 to determine results.

6.0 TESTING ELECTRICAL DEVICES.

6.1 GENERAL. This section presents the various tests that the 250M is capable of performing on electrically operated devices utilizing a power cord with a polarized, 2 pole, 3-wire plug for obtaining power. Devices with leads should be tested in accordance with this section and Section 9.0.

The procedures presented in this section are not meant to imply a safety testing program; see Sections 1.4 and 1.5 for recommended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp light there is greater than 70 volts across the leads; under certain conditions this can present a hazardous situation for the operator.

6.2 MEASURING THE RESISTANCES BETWEEN THE CURRENT CARRYING BLADES AND GROUND PIN.

1. Insert the black lead into the large clamp;
2. Insert the red lead into the probe;
3. Depress the red "MEGOHMS X1" button;
4. While making firm contact between the large clamp on the black lead and the probe on the red lead zero the megohm's scale in accordance with Section 3.8;

PLEASE NOTE: ONE END OF THE BLACK LEAD IS ALWAYS CONNECTED TO THE BLACK "INPUT" JACK, AND ONE END OF THE RED LEAD IS ALWAYS CONNECTED TO THE RED "INPUT" JACK, FOR ALL TESTS PER INSTRUCTION IN SECTION 3.2.

5. Make firm contact between the large clamp and the device's ground pin;

6. Make firm contact between the probe and each one of the device's current carrying blades;

7. See Section 4.8 to determine results.

6.3 MEASURING THE RESISTANCES BETWEEN THE PLUG'S GROUND PIN AND EXPOSED CONDUCTIVE SURFACES.

1. Insert the black lead into the large clamp;

2. Insert the red lead into the probe;

3. Depress the black "OHM X.1" button;

4. While making firm contact between the large clamp on the black lead and the probe on the red lead, zero the ohm's scale in accordance with Section 3.6;

5. Make firm contact between the large clamp and the device's ground pin;

6. Make firm contact between the probe and the exposed conductive surfaces of the device;

7. See Section 4.7 to determine results.

6.4 MEASURING LEAKAGE CURRENTS BETWEEN EXPOSED METAL AND GROUND.

1. Insert the black lead into the 250M's black GROUND" jack;

2. Insert the red lead into the clamp;

3. Plug the 250M into a previously tested polarized, 2 pole, 3-wire grounded receptacle;

4. Plug the device under test into the 250M's receptacle;

5. Depress the black "10 uA CAL. CHECK" button and read in accordance with Section 3.4;

6. Firmly attach the clamp on the red lead to an exposed surface of the device under test;

7. Place the "POLARITY" switch in the "NORMAL" position and the "GROUND" switch in the "GROUND" position;

8. See Section 4.3 for determining results;

9. Place the "GROUND" switch in the "NO GROUND" position and the "POLARITY" switch in the "NORMAL" position;

10. See Section 4.3 for determining results;

11. Place the "POLARITY" switch in the "REVERSED" position leaving the "GROUND" switch in the "UNGROUNDED" position;

12. See Section 4.3 for determining results;

13. Place the "GROUND" switch in the "GROUND" position leaving the "POLARITY" switch in the "REVERSED" position;

14. See Section 4.3 for determining results.

NOTE: If at any time the readings in Section 4.3's X100 micro-amp position go off scale use Section 4.4.

6.5 MEASURING LEAKAGE CURRENTS THROUGH THE GROUND PIN.

1. Insert the black lead into the 250M's black "GROUND" jack;

2. Insert the red lead into the 250M's red "GROUND PIN" jack;

3. Plug the 250M into a previously tested polarized, 2 pole, 3-wire grounded receptacle;

4. Plug the device under test into the 250M's receptacle;

5. Depress the black "10 uA CAL. CHECK" button and read in accordance with Section 3.4;

6. Place the 250M's "POLARITY" switch in the "NORMAL" position and the "GROUND" switch in the "NO GROUND" position;

7. See Section 4.3 for determining results;

8. Place the 250M's "POLARITY" switch in the "REVERSED" position and leave the "GROUND" switch as is;

9. See Section 4.3 for determining results.

NOTE: If at any time the readings in Section 4.3's X100 micro-amp position go off scale use Section 4.4.

6.6 MEASURING THE POTENTIAL DIFFERENCES BETWEEN EXPOSED CONDUCTIVE SURFACES AND GROUND.

1. Insert the black lead into the 250M's black "GROUND" jack;

2. Insert the red lead into the probe;

3. Plug the 250M into a previously tested polarized, 2 pole, 3-wire grounded receptacle;

4. Depress the black "10 uA CAL. CHECK" button and read in accordance with Section 3.5;

5. Make firm contact between the red probe and the exposed surface;

6. See Section 4.5 for determining results.

7.0 TESTING EXPOSED, CONDUCTIVE SURFACES.

7.1 GENERAL. This section presents the various tests that the 250M is capable of performing on exposed, non-current carrying, conductive surfaces that are normally not energized.

The procedures presented in this section are not meant to imply a safety testing program; see Sections 1.4 and 1.5 for recommended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp become lit there is greater than 70 volts across the leads; under certain conditions this can present a hazardous situation for the operator.

7.2 MEASURING THE POTENTIAL DIFFERENCES BETWEEN AN EXPOSED SURFACE AND GROUND.

1. Insert the black lead into the 250M's black "GROUND" jack;
2. Insert the red lead into the probe;
3. Plug the 250M into a previously tested polarized, 2 pole, 3-wire grounded receptacle;
4. Make firm contact between the probe on the red lead and the exposed surface;
5. See Section 4.5 to determine results.

7.3 MEASURING THE RESISTANCE BETWEEN AN EXPOSED SURFACE AND GROUND.

1. Insert the black lead into the 250M's black "GROUND" jack;
2. Insert the red lead into the probe;
3. Depress the black "OHMS X.1" button;
4. While making firm contact between the probe on the red lead and the 250M's ground pin, zero the ohm's scale in accordance with Section 3.6;
5. Plug the 250M into a previously tested, polarized, 2 pole, 3-wire, grounded receptacle;
6. Make firm contact between the probe on the red lead and the exposed surface;
7. See Section 4.7 to determine results.

7.4 MEASURING THE LEAKAGE CURRENT FROM AN EXPOSED SURFACE TO GROUND.

1. Insert the black lead into the 250M's black "GROUND" jack;
2. Insert the red lead into the probe;
3. Plug the 250M into a previously tested, polarized, 2 pole, 3-wire, grounded receptacle;
4. Make firm contact between the probe on the red lead and the exposed surface;
5. See Section 4.3 to determine results.

7.5 MEASURING POTENTIAL DIFFERENCES BETWEEN SURFACES.

1. Measure the potential difference between one of the exposed surfaces in accordance with Section 7.2;
2. Insert the black lead into the clamp;
3. Insert the red lead into the probe;
4. Firmly attach the clamp on the black lead to the previously tested exposed surface;
5. Make firm contact between the probe on the red lead and another exposed surface;
6. See Section 4.5 to determine results.

8.0 TESTING FIXED EQUIPMENT.

8.1 GENERAL. This section presents the various tests that the 250M is capable of performing on electrically operated equipment that is permanently wired to a power source. Devices with leads should be tested in accordance with this section and Section 9.

The procedures presented in this section are not meant to imply a safety testing program; see Sections 1.4 and 1.5 for recommmended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp become lit there is greater than 70 volts across the lead; under certain conditions this can present a hazardous situation for the operator.

8.2 MEASURING POTENTIAL DIFFERENCES BETWEEN AN EXPOSED SURFACE AND GROUND. Follow the procedure presented in Section 6.6.

8.3 MEASURING RESISTANCES BETWEEN AN EXPOSED SURFACE AND GROUND. Follow the procedure presented in Section 7.3.

8.4 MEASURING POTENTIAL DIFFERENCES BETWEEN SURFACES. Follow the procedure presented in Section 7.5.

9.0 TESTING DEVICES WITH LEADS.

9.1 GENERAL. This section presents the various tests the 250M is capable of performing on leads, electrodes, etc. used with electrically operated devices. The device should be tested in accordance with Section 6.0 first. To speed testing of the leads it is suggested that optional Model 10 be used with the 250M.

The procedures presented in this section are not meant to imply a safety testing program; see Sections 1.4 and 1.5 for recommended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp light, there is greater than 70 volts across the leads; under certain conditions this can present a hazardous situation for the operator.

9.2 MEASURING LEAKAGE CURRENTS BETWEEN A LEAD AND GROUND.

1. Insert the black lead into the 250M's black "GROUND" jack;
2. Insert the red lead into the probe;
3. Plug the 250M into a previously tested, polarized, 2 pole, 3-wire grounded receptacle;
4. Attach the leads to the electrical device in the normal manner as though for routine use;
5. Plug the device into the 250M's receptacle;
6. Depress the 250M's black "10 uA CAL. CHECK" button and read in accordance with Section 3.4;
7. Make firm contact between the probe on the red lead and the lead under test;
8. Place the "POLARITY" switch in the "NORMAL" position and the "GROUND" switch in the "GROUND" position;
9. See Section 4.3 for determining results;
10. Place the "GROUND" switch in the "NO GROUND" position and the "POLARITY" switch in the "NORMAL" position;
11. See Section 4.3 for determining results;
12. Place the "POLARITY" switch in the "REVERSED" position leaving the "GROUND" switch in the "UNGROUNDED" position;

PLEASE NOTE: ONE END OF THE BLACK LEAD IS ALWAYS CONNECTED TO THE BLACK "INPUT" JACK, AND ONE END OF THE RED LEAD IS ALWAYS CONNECTED TO THE RED "INPUT" JACK, FOR ALL TESTS PER INSTRUCTION IN SECTION 3.2.

13. See Section 4.3 for determining results;

14. Place the "GROUND" switch in the "GROUND" position leaving the "POLARITY" switch in the "REVERSED" position;

15. See Section 4.3 for determining results.

NOTE: If at any time the readings in Section 4.3's X100 microamp position go off scale use Section 4.4.

9.3 MEASURING LEAKAGE CURRENTS BETWEEN LEADS.

1. Insert the black lead into the clamp;

2. Insert the red lead into the probe;

3. Plug the 250M into a previously tested, polarized, 2 pole, 3-wire grounded receptacle;

4. Attach the leads to the electrical device in the normal manner as though for routine use;

5. Plug the device into the 250M's receptacle;

6. Depress the 250M's black "10 uA CAL. CHECK" button and read in accordance with Section 3.4;

7. Attach the clamp on the black lead to one lead;

8. Make firm contact between the probe on the red lead and the lead under test;

9. Place the "POLARITY" switch in the "NORMAL" position and the "GROUND" switch in the "GROUND" position;

10. See Section 4.3 for determining results;

11. Place the "GROUND" switch in the "NO GROUND" position and the "POLARITY" switch in the "NORMAL" position;

12. See Section 4.3 for determining results;

13. Place the "POLARITY" switch in the "REVERSED" position leaving the "GROUND" switch in the "UNGROUNDED" position;

14. See Section 4.3 for determining results;

15. Place the "GROUND" switch in the "GROUND" position leaving "POLARITY" switch in the "REVERSED" position;

16. See Section 4.3 for determining results.

NOTE: If at any time the readings in Section 4.3's X100 microamp position go off scale use Section 4.4.

10.0 TESTING EXPLOSION-PROOF SYSTEMS.

10.1 GENERAL. This section presents the various tests the 250M is capable of performing on electrically operated devices, equipment, and power systems that utilize explosion-proof receptacles and plugs. To perform these tests the optional NF23-1 and NF23-2 adapters are required.

The procedures presented in this section are not meant to imply a safety testing program; see Sections 1.4 and 1.5 for recommended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp light, there is greater than 70 volts across the leads; under certain conditions this can present a hazardous situation for the operator.

10.2 TYPES OF ADAPTERS.

ADAPTER CORD NF-23-1

The NF23-1 has a male explosion-proof twist lock on one end with a regular female three-prong receptacle at the other.

The male explosion proof twist lock is inserted into the wall mounted, explosion-proof, twist lock receptacle leaving the female three-prong receptacle available so that the test may be conducted.

ADAPTER CORD NF-23-2

The NF23-2 has a female explosion proof twist lock on one end with a regular male three-prong plug at the other.

The female explosion-proof twist lock is inserted into the male explosion-proof twist lock plug from the electrical device, leaving the male three-prong plug available so that the tests may be conducted.

10.3 TESTING DEVICES UTILIZING EXPLOSION-PROOF PLUGS.

1. Insert the black lead into the 250M's black"GROUND" jack;

2. Insert the red lead into the clamp;

3. Connect the NF23-2 to the device under test and plug it into the 250M;

4. Follow the test procedures in Section 6.0 and 9.0.

10.4 TESTING FIXED EQUIPMENT IN EXPLOSION-PROOF AREAS.

1. Insert the male explosion-proof twist lock on the NF23-1 Adapter into the wall receptacle;

2. Follow the test procedures in Section 8.0.

11.0 TESTING ISOLATED POWER SYSTEMS (IPS).

11.1 GENERAL. This section presents the various tests that the 250M is capable of performing on Isolated Power Distribution systems that provide local ungrounded power. To perform these tests the optional NF23-1 and NF23-2 Adapters, along with Model 10, are required.

The procedures presented in this section are not meant to imply a safety testing program; see Sections 1.4 and 1.5 for recommended procedures and practices.

The red and black leads should always be inserted into their corresponding color-coded "INPUT" jacks on the 250M; always turn the 250M "OFF" when testing is complete.

IMPORTANT: Should the 250M's red "DANGER 70V AT INPUT" lamp light, there is greater than 70 volts across the leads; under certain conditions this can present a hazardous situation for the operator.

11.2 MEASURING POTENTIAL DIFFERENCES BETWEEN THE IPS'S GROUNDING POINT AND OTHER GROUNDING POINTS.

1. Insert the black lead into the 250M's black "GROUND" jack;

2. Insert the red lead into the probe;

3. Insert the male explosion-proof twist lock on the NF23-1 Adapter into the wall receptacle;

4. Plug the 250M into the NF23-1's 2 pole, 3-wire grounded receptacle;

5. Make firm contact between the probe on the red lead and the other grounding point;

6. See Section 4.5 to determine results.

11.3 MEASURING RESISTANCES BETWEEN THE IPS'S GROUNDING POINT AND OTHER GROUNDING POINTS.

1. Insert the black lead into the 250M's black "GROUND" jack;

2. Insert the red lead into the probe;

3. Plug the 250M into the NF23-1;

4. Depress the black "OHMS X.1" button;

5. While making firm contact between the probe on the red lead and the large contact plate on the NF23-1's plug zero the ohm's scale in accordance with Section 3.6;

6. Insert the male explosion-proof twist lock on the NF23-1 Adapter into the wall receptacle;

7. Make firm contact between the probe on the red lead and the other grounding point;

8. See Section 4.7 to determine results.

11.4 MEASURING POTENTIAL DIFFERENCES BETWEEN THE IPS'S GROUNDING POINT AND ALL DEVICES, FIXED EQUIPMENT, ETC. SERVICED BY IT.

1. Insert the black lead into the 250M's black "GROUND" jack;

2. Insert the red lead into the probe;

3. Insert the male explosion-proof twist lock on the NF23-1 Adapter into the wall receptacle;

4. Plug the 250M into the NF23-1's 2 pole, 3-wire grounded receptacle;

5. Make firm contact between the probe on the red lead and a device, fixed equipment, exposed surface, etc. serviced by it;

6. See Section 4.5 to determine results.

11.5 MEASURING THE VOLTAGE DROP OF THE IPS'S BRANCH CIRCUIT.

1. Insert the male explosion-proof twist lock on the NF23-1 Adapter into the wall receptacle;

2. Plug the 250M into the NF23-1's 2 pole, 3-wire grounded receptacle;

3. Depress the "VOLTS X10" button;

4. Push the green "RECEPT. TEST" button (NOTE: the neon indication will not be meaningful);

5. See Section 4.6 to determine results.

11.6 TESTING THE LINE ISOLATION MONITOR'S (LIM) TRIP ALARM.

1. Insert the black lead into the 250M's black "GROUND" jack;

2. Insert the red lead into the probe;

3. Insert the male explosion-proof twist lock on the NF23-1 Adapter into the wall receptacle;

4. Plug the 250M into the NF23-1's 2 pole, 3-wire grounded receptacle;

5. Depress the "MILLIAMPS X1" button;

6. Insert the probe on the red lead into the 250M receptacle's hot blade;

7. The LIM's alarm monitor should light or sound an alarm.

11.7 MEASURING THE CURRENT REQUIRED TO TRIP THE LINE ISOLATION MONITOR
See the Instruction Manual of the optional Model 10 for instructions.

12.0 MAINTENANCE INSTRUCTIONS.

12.1 GENERAL. Proper operation of the Model 250M requires that it always be in calibration, the batteries have sufficient voltage and that the fuse be operational.

Whenever the meter indicates low battery voltage during battery check, all three batteries must be changed.

If the Ohm X.1 scale isn't reading properly, check the fuse.

12.2 BATTERY REPLACEMENT.

NOTE: Replace all the batteries.

1. Lay the 250M on its back on a soft surface;

2. Remove the four screws in the bottom of the case;

3. Remove the bottom panel;

4. Reach in and twist the batteries out of their holders;

5. Unsnap the battery clips;

6. Snap new batteries onto the clips;

7. Place the new batteries into the battery holders;

8. Push the "BATTERY CHECK" button and be sure the needle indicates above the black line;

9. Replace the bottom panel being sure that the front and back panels are in the proper grooves in the bottom panel;

10. Replace the screws.

12.3 FUSE TESTING AND REPLACEMENT-OHMS X.1. A 1 ampere fuse protects the ohms circuit from damage due to over voltages. A spare fuse is provided and is located in the fuse clip on the back panel.

The fuse protecting the ohms circuit must be tested if zeroing the meter as described in Section 3.6, can not be accomplished.

1. Twist the cap of the round black fuse holder located on the back panel labeled 1 AMP;
2. Remove the fuse;
3. Look at the glass barrel of the fuse and determine if the small strand of wire in the fuse is intact;
4. If the samll wire is broken, the fuse has failed;
5. Remove the spare fuse labeled 1 AMP from the clip on the back panel;
6. Read the imprint on the metal ends to be sure it reads 1 A;
7. Install the new fuse into the round fuse holder and twist the cap on;
8. Push the "X.1 OHM" button, hold the ends of the leads firmly together and zero the meter by turning the ohms zero knob;
9. If the meter can not be zeroed, see Section 13 for calibration instructions.

12.4 FUSE TESTING AND REPLACEMENT-SWITCHING SYSTEM. A 12 ampere fuse protects the switching system in the 250M from excess currents. A spare fuse is provided and is located in the fuse clip on the back panel.

The fuse protecting the switching system must be tested if the neon light above the receptacle does not light when the 250M is plugged into a live receptacle and the polarity switch is on "NORMAL" or "REVERSED".

1. Twist the cap of the round black fuse holder located on the back panel labeled 12 amp;
2. Remove the fuse;
3. Push the ohms X.1 button and hold the leads firmly together and zero the meter by turning the ohms zero knob;
4. Measure the resistance of the 12 amp fuse;

ACTION: If the resistance of the fuse is less than .5 ohms, the fuse is functioning properly.

If the resistance of the fuse is above .5 or off scale, the fuse is blown and must be replaced.

5. Remove the spare fuse from the fuse clips on the back panel;

6. Read the imprint on the metal of the fuse and be sure it reads 12 A;

7. Place the fuse into the holder and twist the cap back on.

12.5 RECEPTACLE GROUND TENSION TESTING.

1. Using a Bio-Tek Instruments Model T, or equivalent, measure the tension of the ground hole of the receptacle on the front panel;

2. The tension must be greater than 4 ounces to provide accurate and valuable test data;

3. If the tension falls below 4 ounces, the Model 250M must be returned to the factory for repair.

13.0 CALIBRATION INSTRUCTIONS

13.1 GENERAL. It is recommended that the Model 250M be calibrated once a year.

Refer to figure 1 for the position of components discussed in the calibration procedure. The following equipment must be used to calibrate the Model 250M:

D.C. current source for currents from 1 to 15,000 microamps with ±.2% accuracy.

A.C. current source for currents from 1 to 15,000 microamps with ±.2% accuracy.

Resistances of .5, 1.0, 1.5 ohms ±.5%.

Resistances of .5, 1, 5 megohms ± 1%.

Voltage source between 0 and 15 volts ±.2%.

Voltage source of between 0 and 150 volts ±.2%.

Voltage source of between 0 and 300 volts ±.2%.

13.2 MECHANICAL DISASSEMBLY FOR CALIBRATION.

1. Lay the Model 250M on its back on a soft surface;

2. Remove the four screws in the bottom panel;

3. Remove the bottom panel;

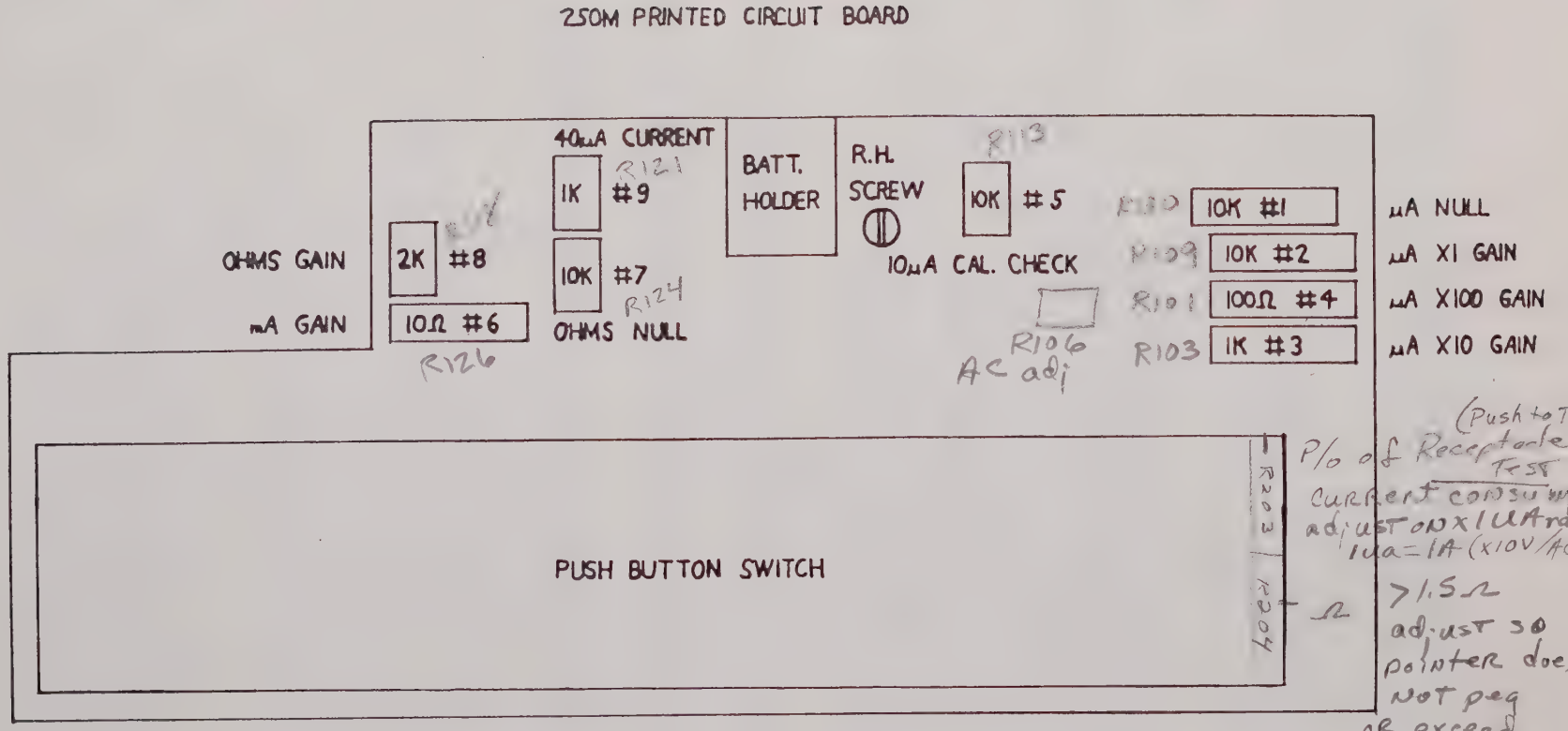


Figure 1
PRINTED CIRCUIT BOARD LAYOUT

4. Remove the round head screw on the printed circuit board;

5. Turn the Model 250M upright carefully holding the front and back panel;

6. Carefully slide the blue cover up and off the front and back panel;

7. Hold the front panel upright;

8. Lay the back panel down on its back;

9. Mechanically zero the needle on the meter by turning the screw on the meter face.

13.3 CALIBRATION MICROAMPS.

1. Push the MICROAMPS X1" button;

2. Short the two jacks labeled "INPUT" together using one of the leads;

3. Adjust the 10K potentiometer #1 so that the meter reads ze

4. Remove the shorted lead on the input jack;

5. The meter should read zero;

NOTE: Meter must read zero in both open circuit and short circuit input before proceding.

6. Put 7.5 microamps D.C. ±.2% into the input jacks;

7. Adjust the 10K potentiometer #2 until the meter reads 7.5 on the black scale;

8. Put 5, 10, 15 microamps D.C. ±.2% into the input and be sure all readings are within 2% of full scale (±.3 microam

9. Push the microamps X10 button;

10. Put 75 microamps D.C. ±.2% into the input jacks;

11. Adjust the 1K potentiometer #3 until the meter reads 7.5 on the black scale;

12. Put 50, 100, and 150 microamps D.C. into the input jacks and be sure all readings are within 2% of full scale (±3 microamperes);

13. Push the microamp X100 button;

14. Put 750 microamps D.C. into the input jacks;

15. Adjust the 100 ohm potentiometer #4 until the meter reads 7.5 on the black scale;

16. Put 500, 1000, and 1500 microamps into the input jacks and be sure that all readings are within ±2% of full scale; (±30 microamperes).

17. Push the "10 uA CAL. CHECK" button;

18. Adjust the 10K potentiometer #5 until the meter reads 10 on the black scale. If the meter will not read 10 microamperes while adjusting potentiometer #5, replace the reference cell located on the printed circuit board with a fresh RMIR (Mallory) cell. These can be ordered from the factory. The normal voltage of the RMIR cell is 1.35 volts.

19. Put A.C. current into the input jacks on each scale to be sure that the 250M reads the r.m.s. value of the A.C. current. Push the D.C. only button and the meter must read 1/100 of the A.C. value.

13.4 CALIBRATION VOLTS.

1. Push the "VOLTS X1" button;

2. Put 10 volts ±.2% into the input and be sure the meter indicates 10;

3. Push the "VOLTS X10" button;

4. Put 120 volts ±.2% into the input and be sure the meter indicates 12;

5. Push the "VOLTS X20" button;

6. Put 120 volts ±.2% into the input and be sure the meter indicates 60 on the black scale.

13.5 CALIBRATION MILLIAMPS.

1. Push the milliamp-X1 button;

2. Put 7.5 milliamp D.C. ±.2% into the input jacks;

3. Adjust the 10 ohm potentiometer #6 until the meter reads 7.5 on the black scale;

4. Put 5, 10, and 15 milliamps into the input jacks to be sure that the readings are within ±2% of full scale (±.3 milliamps).

13.6 CALIBRATION OHMS.

1. Connect a 1,000 ohms resistor across the input jacks;
2. Push the ohm X.1 button;
3. Measure the voltage across the 1000 ohms resistor;

4. Adjust potentiometer #9 until the voltage across the 1000 ohms resistor is 40 millivolts ±2 millivolts;

5. Using a test lead with clips on both ends, connect the fuse holder tab connected to the P.C. board (not the one connected to the red input jacks) of the 1 amp fuse holder on the back panel, to ground on the 1.35 volt battery holder;

6. Using a test lead with clips on both ends, connect the wiper of the "OHMS ZERO" potentiometer (the potentiometer tab closest to the front panel) to ground on the 1.35 volt battery holder;

7. Adjust the 10K potentiometer #7 until the meter reads zero;

8. Disconnect the test leads;

9. Short out the input jacks and zero the meter using the ohm zero knob;

1.5Ω R204 & #8 F.S

10. Connect 1 ohm 1% to the input jacks;

11. Adjust the 2K potentiometer #8 until the meter reads 10 on the black scale;

12. Connect .5 ohm 1% to the input jacks and be sure the meter reads .5 ±5% of full scale (±.075 ohms);

13. Connect 1.5 ohms 1% to the input jacks and be sure the meter reads 1.5 ±5% of full scale (±.075 ohms);

14. If the meter does not read within specifications, adjust potentiometer #8 until the specific accuracy is obtained.

13.7 CALIBRATION MEGOHMS.

1. Push the red MEGOHM X1 button;

2. Short the input out and adjust the megohms zero until the meter reads zero on the red scale (far right);

3. Put .1, 1, and 5 megohms ±1% across the input;

4. The meter must read the resistance ±10% of the reading.

13.8 FINAL INSTRUCTIONS AND ASSEMBLY.

1. Put a drop of nail polish on the turning section of all of the potentiometers;

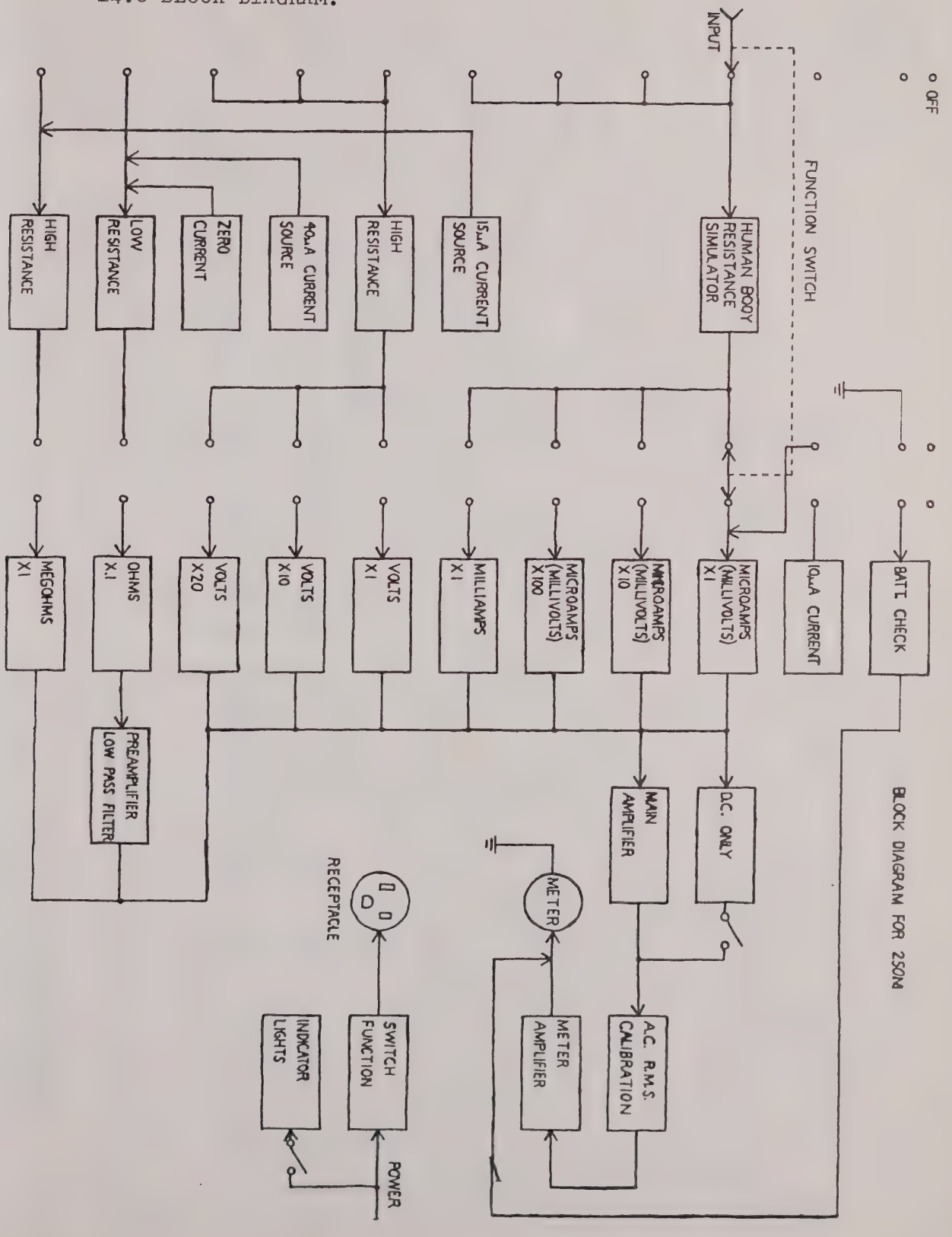
2. Slide the blue cover over the front and back panel being sure that the back panel is in the far outside slot, and the front panel is in the slot directly behind the bezel.

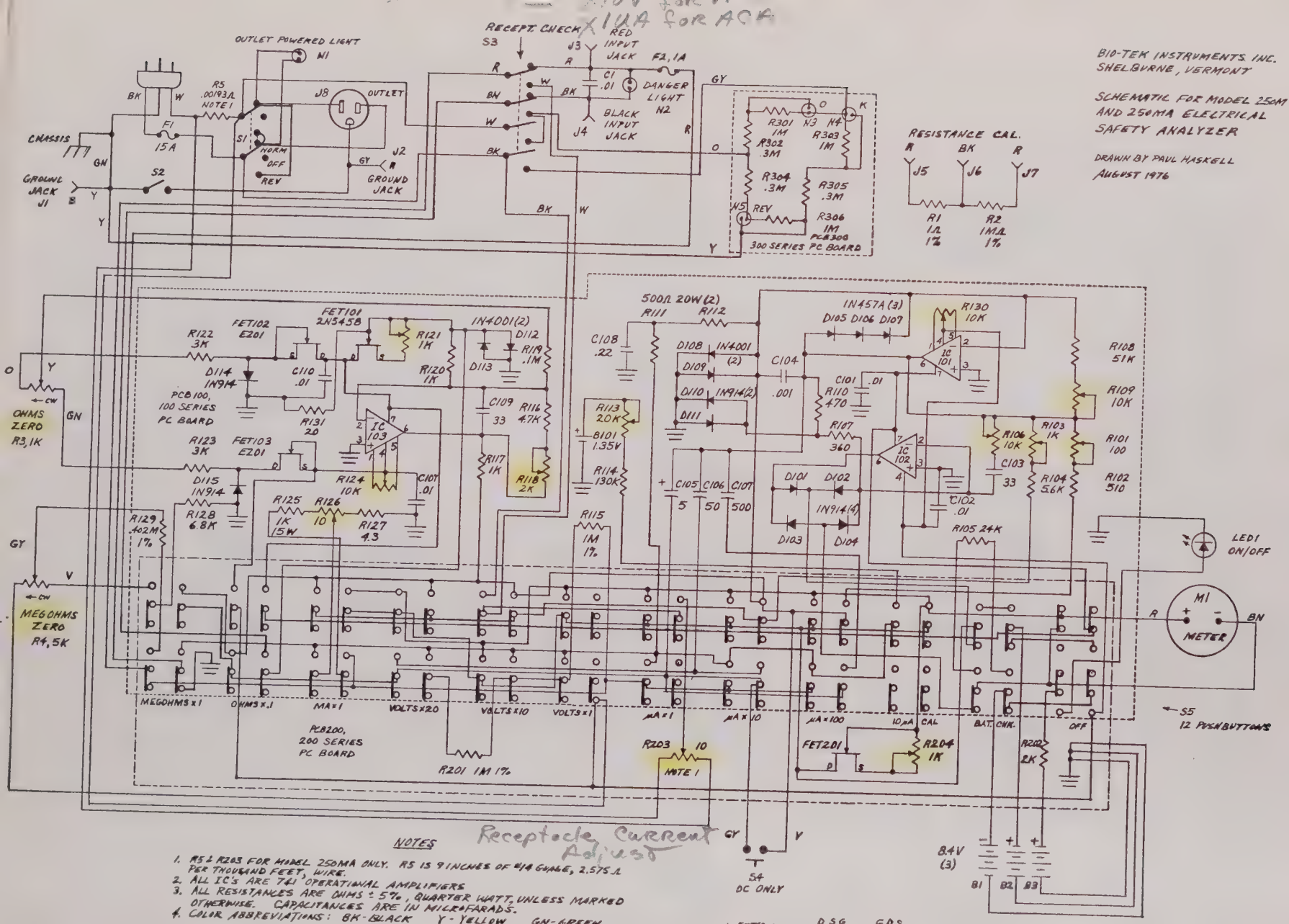
3. Screw the 4-40 round head screw through the board and into the printed circuit board bracket;

4. Put the bottom panel on being sure the front and back panel fit into the grooves in the panel;

5. Put the four screws in snuggly.

14.0 BLOCK DIAGRAM.





NOTES

1. RS & R203 FOR MODEL 250MA ONLY. RS IS 9 INCHES OF #14 GAUGE, 2.575Ω PER THOUSAND FEET, WIRE.
2. ALL IC's ARE 741 OPERATIONAL AMPLIFIERS
3. ALL RESISTANCES ARE OHMS ± 5%, QUARTER WATT, UNLESS MARKED OTHERWISE. CAPACITANCES ARE IN MICROFARADS.
4. COLOR ABBREVIATIONS: BK-BLACK, BL-BLUE, BN-BROWN, Y-YELLOW, O-ORANGE, V-VIOLET, GN-GREEN, GY-GREY

PARTS LIST FOR MODEL 250M/250MA

Circuit Reference	Bio-Tek Part No.	Description	Note
D112	21002	IN4001 diode	
D113	"	" "	
D114	21004	IN914 diode	
D115	"	" "	
F1	46006	15 amp fuse	
F2	46003	1 amp fuse	
FET101	27004	2N5458 FET	
FET102	27001	E201 FET	
FET103	"	" "	
FET201	27003	2N5457 FET	
IC101	23006	741 OP AMP	
IC102	"	"	
IC103	"	"	
J1	42002	Black banana jack	
J2	42001	Red banana jack	
J3	"	" " "	
J4	42002	Black banana jack	
J5	42001	Red banana jack	
J6	42002	Black banana jack	
J7	42001	Red banana jack	
J8	42007	Female 120V jack, Hubbell 5256	
LED1	03002	Red LED	
M1	92005	Meter, Modutec #841-247	
N1	01004	Neon Indicator, Drake 6403-001-583 ON @ 70V	120V ideal
N2	01003	Neon Indicator, Industrial Devices 1050C1	
N3	01006	Neon Indicator, Alco BNF-2 Red	
N4	"	Neon Indicator, Alco BNF-2 Red	
N5	"	Neon Indicator, Alco BNF-2 Red	

* All resistors are $\frac{1}{4}$ w, $\pm$ 5% tolerance unless noted otherwise.

PARTS LIST FOR MODEL 250M/250MA (Continued)

Circuit Reference	Bio-Tek Part No.	Description	Note
PCB100	43004	Bio-Tek 250M-1A PC Board	
PCB200	43005	Bio-Tek 250M-2 PC Board	
PCB300	43006	Bio-Tek 250 PC Board	
R1	32041	1 ohm, ± 1%	
R2	32039	1 Meg ohm, ± 1%	
R3	36001	1 K pot, Clarostat 388N-102	
R4	36002	5 K pot, Clarostat 388N-502	
R101	34002	100 ohm, 10 T pot	
R102	31511	510 ohms	
R103	34004	1 K, 10 turn, pot	
R104	31562	5.6 K ohms	
R105	31243	24 K ohms	
R106	35004	10 K ohms, 1 turn, pot	
R107	31361	360 ohms	
R108	31513	51 K ohms	
R109	34005	10 K ohms, 10 turn, pot	
R110	31471	470 ohms	
R111	33002	500 ohms, 20 watt	
R112	"	" " "	
R113	35005	20 K ohm, 1 turn, pot	
R114	31134	130 K ohm	
R115	32039	1 Meg ohm, 1%	
R116	31472	4.7 K ohm	
R117	31102	1 K ohm	
R118	35003	2 K ohm, 1 turn, pot	
R119	31104	100 K ohm	
R120	31102	1 K ohm	
R121	35002	1 K ohm, 1 turn, pot	
R122	31302	3 K ohm	
R123	"	"	
R124	35004	10 K ohm, 1 turn, pot	
R125	33001	1 K ohm, 20 watt	
R126	34001	10 ohm, 10 turn, pot	

* All resistors are ½ w, ± 5% tolerance unless noted otherwise.

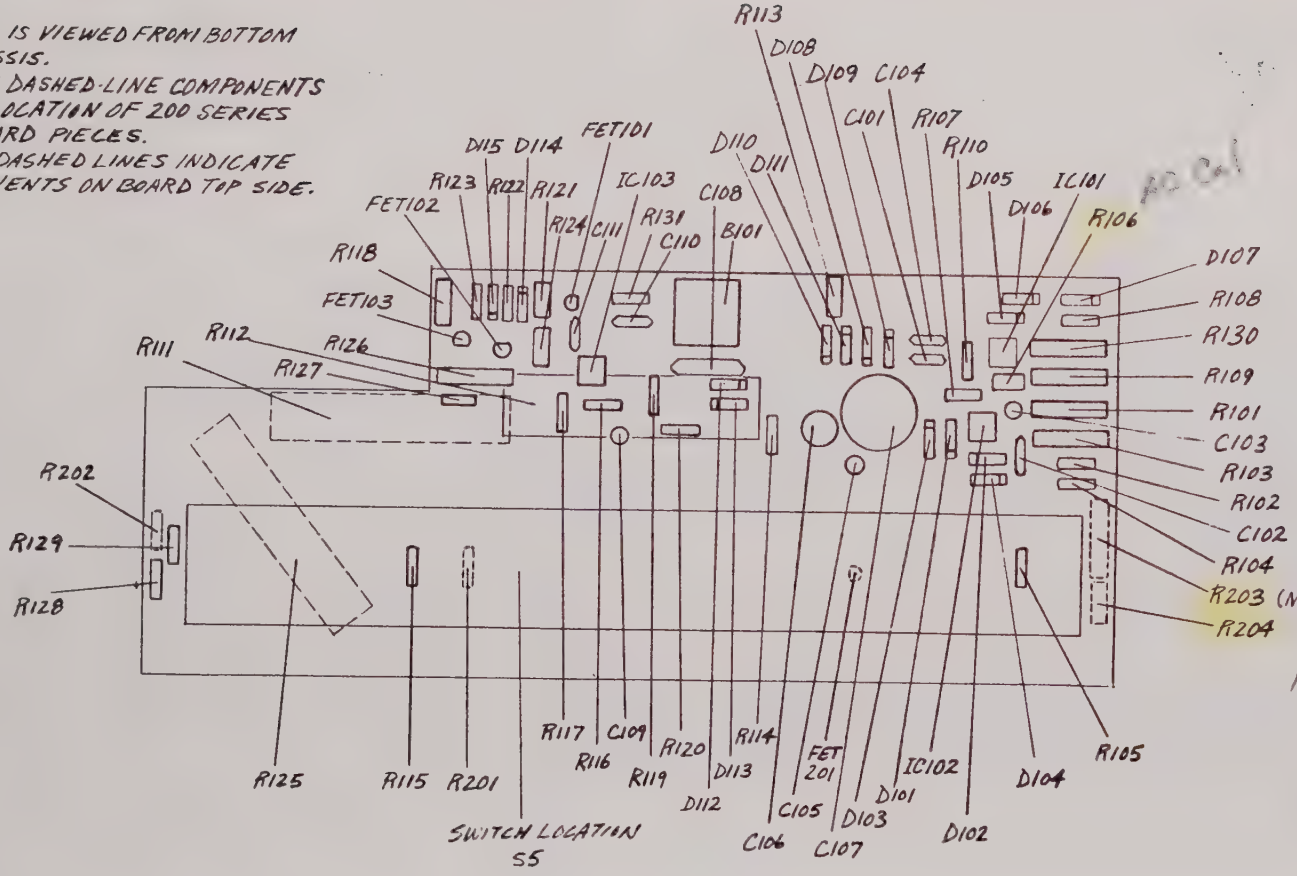
PART LIST FOR MODEL 250M/250MA (Continued)

Circuit Reference	Bio-Tek Part No.	Description	Note
R127	31439	4.3 ohms	
R128	31682	6.8 K ohms	
R129	32036	402 K ohms, ± 1%	
R130	34005	10 K ohms, 10 turn, pot	
R131	31200	20 ohms	
R201	32039	1 Meg ohm, ± 1%	
R202	31202	2 K ohms	
R203	34001	10 ohm, 10 turn, pot	
R204	35002	1 K ohm, 1 turn, pot	
R301	31105	1 Meg ohm	
R302	31304	300 K ohm	
R303	31105	1 Meg ohm	
R304	31304	300 K ohm	
R305	"	"	
R306	31105	1 Meg ohm	
S1	55003	DP 3-pos. toggle	
S2	55001	SPST toggle	
S3	52004	4 pole, single & double throw, pushbutton	
S4	52005	SPST, NO, pushbutton	
S5	52001	12, 4PDT pushbuttons	

* All resistors are ¼ W, ± 5% tolerance unless noted otherwise.

NOTES

1. BOARD IS VIEWED FROM BOTTOM OF CHASSIS.
2. SHORT DASHED-LINE COMPONENTS SHOW LOCATION OF 200 SERIES PC BOARD PIECES.
3. LONG DASHED LINES INDICATE COMPONENTS ON BOARD TOP SIDE.



BIO-TEK INSTRUMENTS, INC.
SHELBURNE, VERMONT

100 & 200 SERIES PC BOARD COMPONENT LAYOUT - MODELS 250M1 & 250 MA ELECTRICAL SAFETY ANALYZER.

PAUL HASKELL, AUGUST 1976

16.0 PRINCIPLES OF OPERATION.

16.1 GENERAL. The Model 250M Electrical Safety Analyzer is a multifunction instrument designed for use as a multimeter and specialized safety test system.

The Model 250M has a 12 station push button switch to control the functions. The "OFF" button disconnects the power and shunts the meter for protection during transit. The battery check button connects the batteries to the meter through an appropriate resistor.

The main amplifier of the system consists of IC 1 and IC 2. When leakage current measurements are being made, the input impedance is 1000 ohms. A T netowrk on the input provides the 0-1.4K Hz frequency response and a capacitor in the feedback of IC 1 provides protection from radio frequencies.

The gain of IC 1 changes from range to range by changing the resistance in the feedback loop. A diode clamping circuit at the output of IC 1, provides over current protection for the meter. IC 2 has a gain of 1 and simply drives the meter. The r.m.s. calibration is provided by a capacitor and resistor in parallel with the input resistor to IC 2.

Voltage measurements are made by connecting a high resistance to the input and measuring the current through it.

The ohms X.1 uses a constant current source of 2 milliamps to produce a voltage which is measured by a preamplifier stage. A large capacitor across the feedback minimizes the effects of 60Hz current.

Megohms is measured by first setting a voltage source to 5 volts, then measuring the current through the unknown resistance.

The precise solid state electronic system of the Model 250M provides accurate data simply and fast. On microamperes, the input impedance simulates the resistance the human body offers to the flow of electricity. Thus the hazard current is indicated directly on the meter face. The resistance scales allow accurate measurement of very low resistances for ground wire measurements and high resistances for measuring isolation of power conductors in an appliance cord. The voltage ranges provide accurate results.

16.2 SPECIFICATIONS-MODEL 250M.

Function and Range	Accuracy	Input Impedance	*Frequency Response
Microamperes X1	±2% F.S. ±.3 Microamperes	1000 Ohms±5%	0-1.4K Hz (AAMI Curve)
Microamperes X10	±2% F.S. ±3 Microamperes	1000 Ohms±5%	0-1.4K Hz (AAMI Curve)
Microamperes X100	±2% F.S. ±30 Microamperes	1000 Ohms ±5%	0-1.4K Hz (AAMI Curve)
Volts X1	±2% F.S. ±.3 Volts	1 Megohm ±1%	0-1.4K Hz
Volts X10	±2% F.S. ±3 Volts	1 Megohm ±1%	0-1.4K Hz
Volts X20	±2% F.S. ±6 Volts	2 Megohm ±1%	0-1.4K Hz
Milliamperes	±2% F.S. ±.3 Milliamperes	1000 Ohms ±5%	0-1.4K Hz
Millivolts X1	±5% F.S. ±.75 Millivolts	1000 Ohms ±5%	0-1.4K Hz
Millivolts X10	±5% F.S. ±7.5 Millivolts	1000 Ohms ±5%	0-1.4K Hz
Millivolts X100	±5% F.S. ±75 Millivolts	1000 Ohms ±5%	0-1.4K Hz

*Average responding, r.m.s. calibrated for sin wave.

Battery Check:

Current drain during battery check: .5 milliamps, battery check independent of electronics. Meter indicates the current flowing through a 24K ohms resistor from the sum of the two battery voltages.

10 Microamperes Calibration Check:

A separate 1.35 volt reference cell provides 10 microamps internaly to check the calibration.

Ohms X.1:

Injection current: 40 microamps ±2 microamps D.C. into 1000 ohms
Frequency Response: D.C. only
Scale: 0-1.5 ohms
Accuracy: ±5% F.S., ±.075 Ohms

Megohm X1:

Injection current: 15 microamps ±1 microamp D.C.
Frequency Response: D.C. only
Scale: Nonlinear 0 to 5 megohms
Accuracy: ±10% of reading

Receptacle Test:

Injection Current into Ground: 200 microamps
Voltage measurement: Voltage hot-neutral

D.C. Only:

At 60 Hz, the Model 250M will read 1/100 of the A.C. value when the D.C. only button is pushed.

Fuse Protection:

Ohms circuit: 1 AMP type 3AG
Switching circuit: 12 AMP type AB

Ampacity:

120 volts, 15 amperes

Cord:

14-3 type SJ, 300 volts, 6 feet long

Plug:

Hospital grade, 3 prong, 15 ampere, 120 volt

"ON" Light:

Runs on third battery. Draws approximately 8 milliamperes. This is independent of any other functions.

Physical Characteristics:

Depth: 4.5"/11.4centimeters

Height: 6.5"/16.5 centimeters

Width: 10"/25.4 centimeters

Weight: 6 lbs./2.8Kg

17.0 FORMULAE AND EQUATIONS

OHMS LAW Voltage (Volts) = Current (Amperes) X Resistance (Ohm

$$V = IR$$

$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

1 AMPERE = 1000 Milliampere

1 MILLIAMPERE = 1/1000 Ampere

1 AMPERE = 1,000,000 Microamperes

1 MICROAMPERE = 1/1,000,000 Ampere

1 VOLT = 1000 Millivolt

1 MILLIVOLT = 1/1000 Volt

1 MEGOHM = 1,000,000 Ohms

1 MILLIVOLT = 1 Microampere X 1000 Ohms

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51258
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